PROBLEMS OF EPIDEMIOLOGICAL GEOGRAPHY
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PROBLEMS OF EPIDEMIOLOGICAL GEOGRAPHY

Report IV. Zonal, Regional and Residual Nosological Areas of Disease

[Following is the translation of an article by I. I. Yelkin and V. K. Yashkul, I Moscow Medical Institute of the order of Lenin imeni Sechenova, published in the Russian-language periodical Zhurnal Mikrobiologii Epidemiologii i Immunobiologii (Journal of Microbiology Epidemiology and Immunobiology), #2, 1964, pages 73-80. The article was submitted to the editors on 24 April 1964. Translation performed by SP/4 Richard M. Koplen]

In report III it was indicated that many modern infectious and invasive diseases of man did not obtain global distribution. The causes of their limited distribution over territories of the world were diverse. Thus, certain naturally focal diseases could not be encountered on these or those territories only because they had not migrated there. Really, migrations of parasitic species were practically possible only in the organisms of carriers (hosts) and vectors. Therefore, their regular and mass spreading beyond the limits of the areas could be found most frequently in connection with the migrations of man himself and the animals transported with him, chiefly farm and synanthropic animals. At the same time wild ground animals, excluding migratory birds and parasites transferred by them, could migrate during a stretch of time, incommensurable with periods of geological history, for relatively limited distances.

Of course, on the level of current medical-geographical knowledge in many cases it is difficult still to predict what territories of the world are potentially dangerous in the sense of the formation in their limits of natural foci of concrete diseases which were not distributed there up to now (usually investigators find out about such territories, post factum). However, we weren't able to exclude the presence of potential areas* for a number of causative agents of naturally focal diseases. In particular, it is very probable that South America is a territory favorable for the formation of secondary natural foci of tularemia among pigs. Some authors consider also that favorable conditions for the implanting of yellow fever exist in countries of tropical Asia (Burnet, 1946) etc. * In biogeography the term "potential areal" is understood to mean those sectors of territories or aquatoria which have all the necessary conditions for supporting the continuity of existence of a given group of organisms, but in the confines of which these organisms are not disseminated.

Along with this, the causative agents of many diseases which do not have global distribution as a result of the intensive economic activity of

man and close intra- and intercontinental contact between people during the virtual absence of quarantine service, repeatedly migrated beyong the limits of their areas. Thus, epizootics are known of plague among rats in port cities of Norway, and epidemics of yellow fever---in many port cities of the Mediterranean, where these diseases never became endemic. Far from the limits of nosological areas, cases were recorded of illnesses of people with leishmaniases and mainly locally distributed helminthiases, etc. The leading factors hindering the implantation and distribution of infections and invasions beyond the limits of the areas of their causative agents in these cases were, first of all, the natural-geographic conditions. The reasons for the dependency of the distribution of infections and invasions on conditions of the geographic environment should be searched for primarily in the features of the life scheme of causative agents, for the implanting of which on these or those territories strictly defined conditions are required which are absent in many climatic and landscape zones of the world.

Thus, two main factors (the insurmountable obstacles arising on the paths of settling of the causative agents of diseases, and the impossibility of their implantation on these or those territories) led to the fact that a considerable number of infectious and invasive diseases of man have zonal and regional nosological areas.

Such infectious and invasive diseases of man which are endemic for fully defined zones of the world have zonal nosological areas. Usually such nosological areas, in the form of a band, encompass the whole world or at least a large part of it. Besides, the zonal distribution of diseases is found in direct or indirect relation with definite climatic and landscape zones of the world. Thus, many geohelminths have zonal nosological areas due to the fact that in the bleak climate of high north and south latitudes their eggs can not successfully develop in the soil (ascariasis, trichocephaliasis, ancylostomiases, strongyloidiasis and others). Certain obligate-transmissive diseases (for example, dengue, phlebotomus fever) have a zonal distribution in connection with the zonal types of areas of their carriers.

As in the cases with global nosological areas, man and his practical activity had an enormous influence on the formation of zonal nosological areas. Thus, dengue fever at present has an expressed zonal distribution. It's foci encompass considerable territories of the tropical and subtropical belt (fig. 1). However, previously dengue had a more limited distribution. Its original native land should be considered as tropical Africa and India, where it, in all semblance was primarily a disease of monkeys. The history of epidemics of dengue testifies that the causative agent of this disease already existed long ago in rural areas of tropical Asia (Smith, 1956). Forest animals were the basic carriers of this infection, and vectors--mosquitoes inhabiting the tops of trees. It should be assumed that

owing to the constant drawing in of people in the circulation of infection among animals, this disease already long ago was turned into an anthropozoonosis. Only in the 14th century was the distribution of dengue essentially changed in connection with the broadening of one of the vectors of virus---the mosquito Aedes aegypti, which became a synanthrope. This mosquito propagated itself in ports and then also in other cities of tropical Asia and was brought in to America, which led to mass epidemics of dengue among the urban population which were extinguished only after immunization of the population.

Infectious and invasive diseases of man also have regional nosological areas which are endemic for more or less limited areas of the world. The bulk of these diseases were transmissive infections and invasions. Among anthroponoses cholera is the only exception, and among zoonoses and anthropozoonoses--invasions, the intermediate hosts of which are molluscs (clonorchiasis, schistosomiases).

Causative agents having regional areas, as a rule, are extremely ancient parasites which emerged long before the appearance of man in the living arena. The emergence of the causative agents of these diseases in the majority of cases was connected with the geographical formation of species of any suitable parasitic form. As a result of such an evolution, in each individual case there emerged a group of closely related nosological forms (a group of viral tick-borne and mosquito-borne fevers, a group of naturally focal rickettsioses, a group of tick-borne recurrent fevers, etc.). Each of the individual nosological forms of a specific group had a more or less limited distribution, while the sum total of nosological areas of all groups as a whole occupied extensive territories of the earth.

As an example of such a path of formation of nosological areas, it is possible to cite the process of geographical species formation in a group of causative agents of tick-borne recurrent fevers---spirochaetes of the genus Borrelia. The initial form of modern causative agents of tick-borne recurrent fevers, evidently, were commensals of Ornithodoros ticks and at present there are a large number of such forms (Shteynkhauz, 1947). Apparently, these spirochaetes, in the process of philogenetic adaptation to rodents still in the age of their emergence and the first stages of settling, became parasites of warm-blooded animals. Along with this, ticks proved to be steadfast keepers of causative agents, which together with their own carriers formed local groups in strictly defined landscape-geographical areas of the world. In so far as ecological peculiarities of carriers (primarily the lack of their inclination for migration) to a significant degree stipulated the geographical isolation of initial forms of spirochaetes, in various corners of the world in the process of adaptation to peculiarities of the specific environment of habitation, various geographical populations (subspecies) were formed and possibly also independent species of the genus Borrelia (fig. 2). In later time synanthropic forms

of Ornithodoros emerged, in connection with which "settlement foci" of tick-borne recurrent fever were formed, and in these foci it became an anthropozoonosis.

At present the battle with tick-borne recurrent fevers is being conducted on an extremely limited scale and the nosological areas of these diseases essentially coincide with the areas of species of the genus Borrelia.

Cholera occupies a special place among regional anthroponoses. Endemic foci of this disease were formed relatively late in the region of ancient riparian cultures. In the Ganga and the Brahmaputra valleys, as a result of the highly unusual natural and social-economic conditions of the people's lives (marsh-ridden country with hot climate and high density of population, and also the mass contamination of drinking water with excrement), conditions arose for the transition to parasitism by means of adaptation to man by the free-living aquatic vibrios. For the extent of all history human cholera repeatedly exceeded the bounds of endemic foci (fig. 3), having a distribution close to global. However, its nosological area never changed. All foci of cholera which emerged outside the limits of India and Pakistan proved to be temporary and either disappeared spontaneously or were liquidated relatively easy by the efforts of the people. The present rise of cholera incidence in humans in the neighboring countries of Asia and Africa are dependent on its endemic foci and are actually outlying sectors of the infection. In the limits of specific nosological areas, be it global, zonal or regional, a given nosological form as a rule is not encountered everywhere. That is why more or less complex "mosaic" nosological areas are formed. Such a map of the breakdown of nosological areas appears in connection with the fact that individual "foci" of a given infectious or invasive disease prove to be, to a greater or lesser degree, disconnected from each other in connection with the heterogenous arrangement over the territory of conditions of material life of society. Along with this, in some cases "mosaic" nosological areas completely envelop definite territories of the land, and in other cases in this or that place they prove to be discontinuous. On account of this, nosological areas, based on form, should be divided into continuous and discontinuous. Usually continuous nosological areas are more or less integral territories of the continent where the given nosological form is endemic; discontinuous (disjunctive) areas are composed of a number of endemic territories, based on the specific nosological form, which were sufficiently separated by spacious sectors for which the given disease is not endemic.

The borders of specific nosological areas have an extremely complex configuration and are mobile in time. The degree of stability of nosological areas may be diverse. The spreading of many infections and invasions on the land in our time reached their own limiting borders. Also nosological areas usually prove to be relatively stable (for example, global nosological areas). If the same nosological area of a given infection or infestation is only in

the process of formation and still has not reached the limits which are stipulated by the territorial disposition in the world of the conditions of material life of society, its borders, in the course of a relatively small period, can change considerably and such nosological areas prove to be unstable.

The fact that the instability of nosological areas is able to arise also in connection with the direct interference of man in the epidemic process is worthy of special attention. In these cases a reduction of the nosological area in connection with the liquidation of human incidence on territories of this or that country can be observed. Along with this, on vast territories of the world the social-economic conditions of people's lives remain extremely difficult. Up to now a considerable number of states are under the colonial yoke. The historical heritage of colonial politics of imperialism also places a heavy burden on many countries which now have gained independence, but still haven't reached a more or less satisfactory level of production of material wealth. Besides this, the monopoly of private enterprise in the medical services of the population in many capitalistic countries hampered the putting into practice of wide prophylactic measures on a national scale. This leads to the fact that a number of infectious and invasive diseases of man which were liquidated on territories of some countries, still are widely distributed in other countries.

Thus, the reduction of nosological areas in connection with the liquidation of human incidence on territories of these or those countries in our time leads only to the emergence of unstable nosological areas. However, these diseases still prove to be widely distributed. Their nosological areas we propose to name residual, in as much as they occupy territories of the world in the limits of which a specific infectious or invasive disease still retained its endemicity, but the effective prophylactic means now at man's disposal led to its eradication in other territories.

It is necessary to emphasize that territories in the limits of which human illnesses are already eradicated, in their epidemiological sense often essentially differ from those territories where the given nosological form was not endemic earlier. Only the constant active antiepidemic activity of man here hinders the appearance of endimicity, since within their limits there are preserved all the conditions which are necessary for the taking root and distribution of the causative agents. The reduction of effectiveness of antiepidemic measures inevitably leads to the fact that these territories once again became endemic based on the relation to a definite nosological form. In accordance with this, we can designate such territories as potential nosological areas of certain infections or infestations.

The presence of potential nosological areas may be stipulated also by a number of other reasons. In particular, as already mentioned, certain diseases up to now still haven't reached maximum distribution and on the

globe there are still such territories (designated by us as potential nosological areas) where these diseases can become endemic if the causative agent is brought in there. Side by side with this, in the case of naturally focal diseases with potential nosological areas there should be a consideration of the whole combination of territories of natural foci where human illnesses are not encountered because of the absence of man or particular conditions of his life, which in the given period of time rule out the emergence of illness. For example, one should consider as potential nosological areas the territories of natural foci of this infection which are located in North America, the deserts of Middle Asia and certain highly mountainous regions of Pamir and Tian Shan, and also certain territories of natural foci of jungle yellow fever, etc.

Thus, such territories of the globe lying beyond the limits proper of nosological areas of given infectious or invasive diseases, where in a given time the disease can take on only an exotic character or not be encountered at all, but where during a relatively short period conditions can arise for the appearance of endemicity, should be designated potential nosological areas.

The geographical distribution of small pox can serve as an example illustrating residual and potential nosological areas. The virus of small pox evidently emerges as a result of the philogenetic adaptation of a small pox like virus of domesticated animals to man, which can occur in South-West and Middle Asia and North Africa. Historical monuments testify to the fact that Egyptians were ill with small pox in 1200--1100 years, and according to some data---in 3730--3710 years before our era (Ruffer, 1921). The first authentic information concerning epidemics of small pox in Asia dates from the VI---XI century of our era. Small pox was known in Europe since the VI century. It was brought in by Europeans to the New World, where devastating epidemics arose at first after which small pox became endemic in America. Thus, small pox had global distribution a few centuries ago. The discovery by Jenner gave man a powerful weapon for combating small pox, as a result of which at present it has been eradicated in many countries (fig. 4). However, the residual nosological areas of small pox still are great. It is known that at the present time, according to the proposal of the Soviet Union which was introduced in the World Health Organization, a program has been worked out for the eradication of this infection on the whole globe and it undoubtedly will be one of the first infectious diseases of man to be eradicated on the land.

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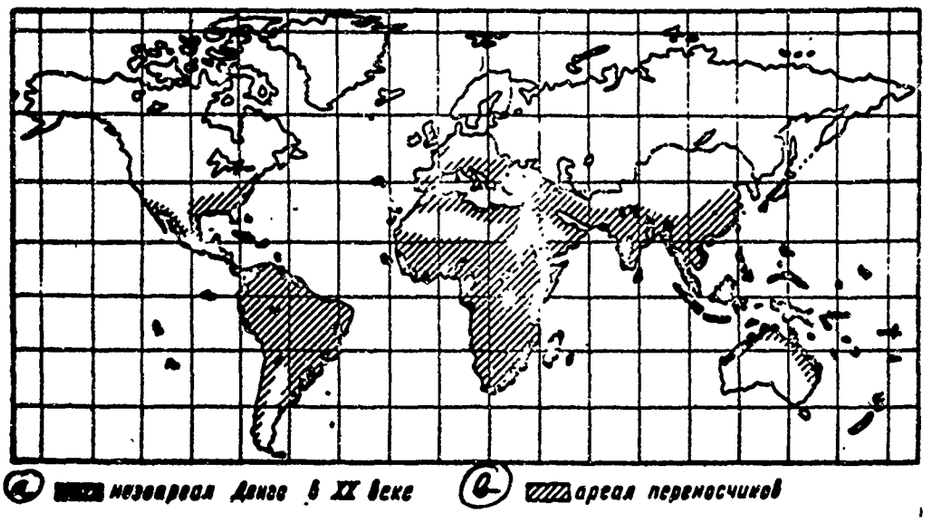

Figure 1. Worldwide distribution of dengue.

a. Nosological area of dengue in the XXth century

b. Areal of the carriers

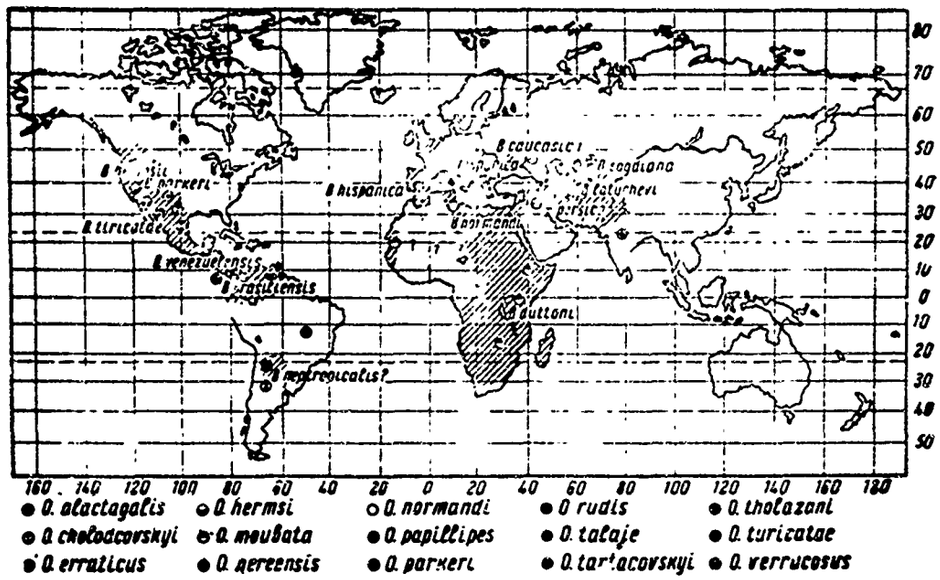

Figure 2. Distribution of tick-borne spirochetoses.

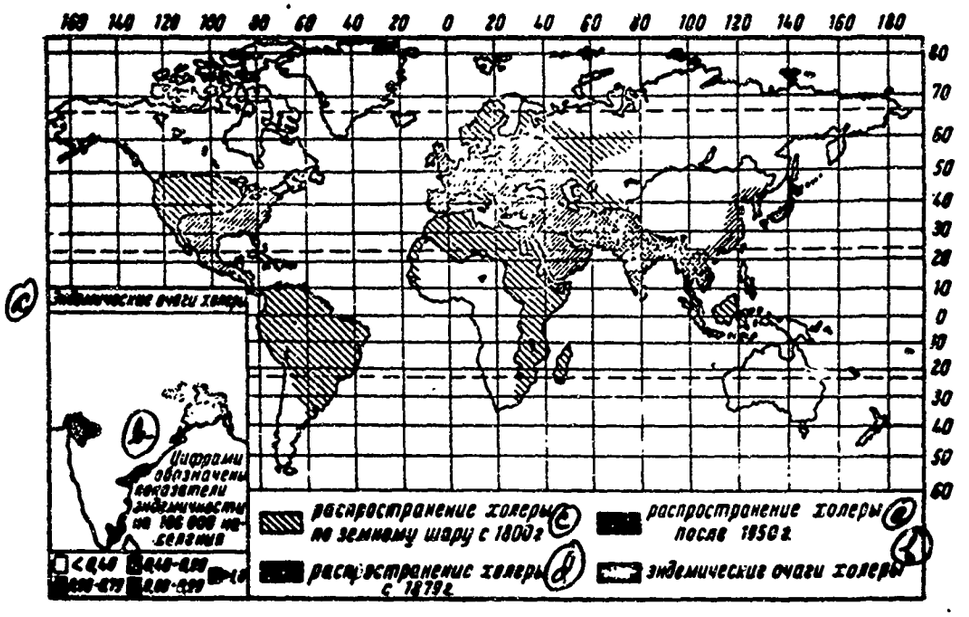

Figure 3. Distribution of cholera in the XIX--XXth centuries (Based on data of the World Health Organization).

a. Endemic foci of cholera
b. Figures designate the endemicity indices per 100,000 population
c. Worldwide distribution of cholera since 1800
d. Distribution of cholera since 1879
e. Distribution of cholera after 1950
f. Endemic foci of cholera

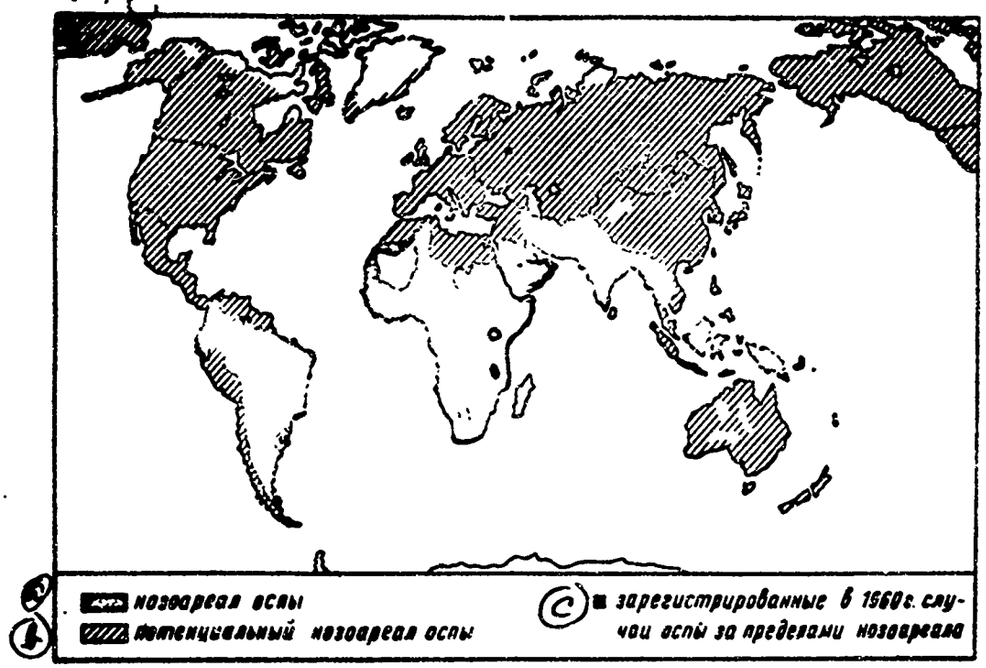

Figure 4. Geographical distribution of smallpox in 1960.